of this imaging modality possible was radioactivity by Bacquerel in 1896. Bacquerel shared the Nobel Prize in physics with Pierre and Marja Curie in 1903 for their discoveries related to radioactivity. Another discovery which led to the development of nuclear imaging was that of technetium in 1937. Technetium-labeled molecules, known as radiopharmaceuticals, which have specific biological functions, are used. The first imaging procedures were performed in the 1940s. The presence of a brain tumor was detected and normal and abnormal thyroid functions were investigated. Both experiments used ^{131}I . The Anger scintillation camera, developed in the 1950s, is the primary detector in nuclear medicine. Although the groundwork development of single photon emission computed tomography (SPECT) and positron emission tomography (PET) preceded x-ray-based CT, it was not until the development of CT imaging, and the related reconstruction algorithms, that SPECT and PET were developed to the state of clinical utility.

Theory and Equipment. The basic principle behind nuclear medical imaging is that a radiopharmaceutical can be introduced into the body which emits radiation detectable outside of the body. Radiopharmaceuticals are biologically active and have a short half-life ($T_{1/2}$). The detectable radiation is typically a γ-ray photon. The radiopharmaceutical must be introduced in sufficient concentration to produce detectable signals outside of the body, but not large enough to be lethal. Some radiopharmaceuticals emit γ-rays directly. Other radiopharmaceuticals emit positrons, β^+. Shortly after being emitted, the positron is annihilated when it collides with an electron. Two 511-keV photons are simultaneously produced from the annihilation and possess trajectories 180° apart from each other. The more common radioactive nuclei used in radiopharmaceuticals are listed in Table 4. With the exception of xenon, these nuclei are typically bonded to other atoms or complexed with chelates to form the radiopharmaceutical. The specific structure of the radiopharmaceutical depends on the application.

Table 4. Radioactive Nuclei Used in Radiopharmaceuticals[a]

Nucleus	Radioactive decay product	γ-Ray energy, keV	$T_{1/2}$	Production[b]
^{201}Tl	γ	70	73 h	CPB
^{133}Xe	γ	81	5.27 d	fission
^{131}I	γ	364	8.05 d	fission
^{123}I	γ	159	13 h	CPB
^{111}In	γ	171, 245	67.9 h	CPB
$^{99}Tc^m$	γ	140.5	6.03 h	^{99}Mo decay
^{82}Rb	β^+	511	1.2 min	^{82}Sr decay
^{67}Ga	γ	93, 184, 300	78.3 h	CPB
^{18}F	β^+	511	110 min	CPB
^{15}O	β^+	511	2 min	CPB
^{13}N	β^+	511	10 min	CPB
^{11}C	β^+	511	20.5 min	CPB

[a]Refs. 21 and 67.
[b]CPB = charged-particle bombardment.

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Appendix A